Water Heating: Distribution Loss Performance Improvement Options

Description
Distribution loss, and its impact on residential energy use, was evaluated in detail in the 1990s to develop the compliance procedures currently in use. For the 2005 *Standards*, a more-detailed investigation of distribution losses is proposed to address several issues needing further study. Specific measures being proposed for re-evaluation include insulation of hot water piping including piping under slabs; pipe size; distribution losses for large custom homes that are outside the bounds of the assumptions implicit in the *Standards*; and appropriateness of current calculations for all recirculating systems including losses from recirculating hot water systems for single family and multifamily buildings. This evaluation will include the possibility of more accurately quantifying high energy usage of poorly designed systems making room for credits for better performing systems and considering alternative methods of achieving high efficiency distribution systems. TDV accounting will also require reevaluation of distribution losses.

Benefits
Refining distribution loss assumptions will improve the accuracy of compliance calculations. These improvements are expected to more accurately calculate the high energy use of poorly designed systems, and result in significant energy savings and demand reduction.

Environmental Impact
The environmental impacts of this measure are projected to be favorable.

Type of Change
The proposed changes will affect the *Standards'* baseline and modeling assumptions. The distribution system compliance options, particularly for continuous recirculating systems, poorly designed distribution systems, and more effective options, would also be modified as result of this work. Changes may in include requiring insulation on hot water pipes including those slabs and disallowing pipe diameters larger than inlet pipes. Under-slab pipe insulation, if deemed cost-effective, would be a mandatory measure. The *Standards*, ACM manual, and compliance forms will be affected by these changes. Labeling of insulation with the R-value may be considered to aid inspection.

Measure Availability and Cost
The cost of implementing the pipe insulation measure can be readily determined for individual projects; however, an assumption of "length of insulation per square foot of house" needs to be developed before a "standard" cost can be identified. There are no maintenance costs. Insulation is widely available from plumbing suppliers, and is already required for hot water recirculation systems. Other measures, which would add to construction costs, may be identified in the course of re-evaluating distribution loss. The baseline condition for pipe insulation would be a typical house with uninsulated hot water piping in the attic and below the slab, which are currently common practices.

Useful Life, Persistence and Maintenance
The lifetime of the commonly-used, expanded polyethylene insulation in under-slab locations should be greater than 50 years, although there are no known studies in this area. Persistence and maintenance issues need to be evaluated.

Performance Verification
Insulation can be inspected coincident with the rough-in plumbing inspection. There are no verification or commissioning costs. Performance verification is not currently expected to be required.

Cost Effectiveness
In previous standards development work, under-slab pipe insulation was found to be marginally cost-effective, because it only provides benefit when the interval between draws is fairly short. Thus, cost-

effectiveness depends upon the assumed piping design and draw schedule. Investigations completed using more recent data on piping design and draws may lead to different conclusions. With TDV considerations, insulation is very likely to be cost-effective for electric water heating systems.

Analysis Tools

The HWSIM model, used in the development of the distribution loss assumptions in the current standards, still appears to be the best available evaluation tool for distribution system losses. The existing water heating methodology, the HWSIM distribution loss model used in the 1991 work, and the WHAM model will be employed to determine the overall effect of distribution system design alternatives, including pipe insulation. It may be necessary to develop an additional model for simulating loss of large recirculation systems or to use with the DOE2 simulation program for analysis purposes.

Relationship to Other Measures

There are likely to be interactions between this measure and other proposed water heating measures.

Bibliography and Other Research

The following data is available and will be reviewed in the course of this work:

Davis Energy Group. *California Residential Water Heating Standards – Volumes I – III, 1991*. These volumes represent the technical basis for the existing water heating standards.

Davis Energy Group. *Parallel Piping Studies*, 1991.

USDOE Technical support document on water heating, 2000.

LBL-37805. *Modeling Patterns of Hot Water Use in Households*, November 1996. Includes information on use patterns and description of the WHAM model.

TDV studies completed for PG&E.

Water heating load profile data from various sources, including PG&E.

CEC PIER Project on water heating distribution systems, DEG and ORNL Contractors

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